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ABSTRACT

We use data from the third National Health and Nutrition Examination Survey to examine the prevalence and determinants of poor nutritional outcomes among American youths. One strength of our analysis is that we focus on an array of nutritional outcomes, and we find in fact that the determinants of these outcomes vary considerably form outcome to outcome. We interpret our results using a model in which investments in health capital are affected by both resource constraints and a human capital production function that summarizes available nutrition information. We find that although many youths suffer from nutrient deficiencies, these conditions are not generally sensitive to measures of resource constraints, and hence are unlikely to be due solely to a shortage of food. Conversely, we find that our proxies for information matter. Our results suggest that broad-based policies designed to alter the composition of the diet may hold the greatest promise for addressing the nutritional problems of American youths.

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1. Introduction

The words "youth malnutrition" conjure up images of gaunt, starving waifs. Fortunately, such extreme nutritional deprivation is rare in the United States and in other developed countries. Nevertheless, as we will show, there are many American youths who are "misnourished". The nutritional problems prevalent in the West are generally due to the composition of the diet—many youths under-consume important nutrients while over-consuming calories and high-fat foods. This pattern is linked to the increasing prevalence of obesity, which has important long-term health consequences. Poor diet quality (e.g. over-consumption of fats and under-consumption of foods such as fruits and vegetables) has also been increasingly linked to the development of leading killers such as cancer and heart disease in later life.

Standard human capital theory suggests that youths (or their parents) choose diets in order to maximize utility, subject to two sets of constraints. The first constraint, is the information that they have available about the link between food inputs and health outcomes that they care about. The second constraint is the household budget. This formulation leads naturally to the question of whether misnourished youths lack information about the relationship between nutrition and health, or whether they lack resources (which would imply that nutritional problems were heavily concentrated among the poor)?

U.S. public policies concerning nutrition are generally predicated on the notion that resource constraints are of paramount importance. In order to assess this hypothesis we focus on an array of outcome measures including various nutritional deficiencies, obesity and high cholesterol, measures of overall dietary quality, and food insecurity.

Food insecurity is the most commonly used measure of nutritional status. It can be thought of as uncertainty about where ones next meal is coming from. We find that while poor youth ARE more likely to suffer from food insecurity, they are also more likely to be obese than other youths. Yet they are no more likely to suffer vitamin deficiencies, and the overall quality of their diets is no worse than that of other youths.

Thus, resource constraints alone cannot explain the patterns we see. On the other hand, proxies for information are very important. Youths in households with more educated heads are less likely to be obese, eat healthier diets, and are less likely to suffer from food insufficiency, other things being equal. We also find that school meals programs have positive effects on the quality of the diet, which is likely due to the fact that they are mandated to follow particular meal patterns.

These findings all suggest that policies designed to alter the composition of the diet are likely to more effectively address the nutritional problems of American youth than those policies (like Food Stamps) that merely seek to increase the quantity of food consumed.

The rest of the paper is laid out as follows. In Section I, we discuss important background information related to the measures of nutritional status that we examine. In Section II, we provide an overview of the human capital theory underlying our approach. Section III provides an overview of the data, while Section IV presents our main results. Conclusions follow in Section V.

2. Background

2.1 Measures of Nutritional Status

As discussed above, measures of nutritional status can be grouped into four broad categories:

Food insecurity, dietary quality (measured using dietary intake surveys), and measures of nutritional deficiency and obesity that are based on physical examinations. This section discusses the pros and cons of the different measures.

2.1.1 Food Insecurity

The most commonly used measure of nutritional status in the U.S. is "Food Insecurity" which is often defined as missing a meal because there was no food in the house, or because there was no money to buy food. More simply, respondents may be asked if there is "enough food to eat, sometimes not enough to eat, or often not enough to eat", as they are in the NHANES III. A recent USDA report (Nord, Jemison and Bickel, 1999) found that 1 in 10 U.S. children suffered from food insecurity.[1] This estimate is almost double our estimate for adolescents of 5.5%.

The link between food insecurity and actual nutritional deficiencies is however, unclear. In the USDA study, only 3.5% of households had food insecurity severe enough that one or more household members were hungry at some point during the year. Rose and Oliveira (1997) use data from the longitudinal 1989-1991 Continuing Survey of Food Intake by Individuals and find a negative relationship between food insecurity and nutrient intakes among young women and the elderly, but not among children. Wilde (1997) and Wilde and Ranney (1997) use data from the Consumer Expenditure Survey and find that while adults in families using Food Stamps frequently eat less during the fourth week of the month (the benefits are issued monthly), children do not. These findings suggest that parents are largely successful in shielding their children from the

[1] The definition used in this study included those who answered yes to questions ranging from: "We worried whether our food would run out before we got money to buy more" to "In the last 12 months did any of the children ever not eat for a whole day because there wasn't enough money for food?"

nutritional effects of food insecurity, though such insecurity could well have negative psycho-social consequences. As we will show below, we also find little relationship between food insecurity and measures of nutritional deficiencies.[2]

2.1.2 Dietary Recall

A second common source of information about nutrition is dietary recall data. Respondents are typically asked to keep a food diary for lengths of time varying from 1 or 2 days, up to one week. In the NHANES III, respondents were asked how many times they ate various foods in the past month. Nutrient values are then calculated based on the respondent's account of the types of foods and amounts that were eaten. Since food intakes vary a great deal from day to day, food intakes measured over longer periods are considered more accurate (see Beaton et al. 1997).

Because dietary recalls are self-reported, there is a possibility of systematic bias. For example, Briefel et al. (1997) compare the self-reported energy intake information derived from NHANES III with a measure of basal metabolic rate for sedentary individuals derived from fundamental principles of energy physiology (Goldberg et al., 1991). They find that 18% of men and 28% of women under-report their consumption of energy. Under-reporting is greatest among overweight individuals and among those trying to lose weight.

Nevertheless, food frequency questionnaires provide useful information for researchers.

[2] Still, some would dispute this assessment. For example, Neuhaser et al. (1995) estimate that 2 million children in California alone go hungry because their parents do not have the resources to buy food. They obtain this estimate by comparing estimates of total family income less other necessities with the amount necessary to purchase an adequate diet. However, their estimates are much higher than those obtained from surveys of the poor, probably because they underestimate the total resources available to households. Frank et al. (1996) show that the fraction of emergency room visits accounted for by children who are small for their age rises during the winter months in a Boston hospital. They attribute this to a "heat or eat" effect, but it could also be due to selection if small children are more susceptible to illness.

Studies generally report moderate to high correlations between the dietary information gleaned from food frequency questionnaires and methods that rely on direct observation (c.f. Rockett and Colditz, 1997). Since extensive food diaries and direct observation place considerable burdens on researchers and subjects, and since the act of observation may by itself alter the diets of subjects, food frequency questionnaires are an indispensable tool for nutrition researchers.

We have adopted USDA's Healthy Eating Index (HEI) as a way of summarizing the food diary information available in the NHANES III (Kennedy *et al.*, 1995).[3] The USDA uses the HEI to assess overall diet quality. The index has 10 components, and each component is scored between 0 and 10. The components and the scoring algorithms are shown in Chart 1. Intakes that fall between the criteria for scores of 0 and 10 are scored proportionally.

Chart 1: Components of the HEI

Component	**Criteria for score of 10**	**Criteria for score of 0**
1. Grains	6-11 servings*	0 servings
2. Vegetables	3-5 servings	0 servings
3. Fruits	2-4 servings	0 servings
4. Milk	2-3 servings	0 servings
5. Meat	2-3 servings	0 servings
6. Total fat	<31% calories from fat	>46% calories from fat
7. Saturated fat	<10% calories from s.f.	>14% calories from s.f.
8. Cholesterol	<300 mg	>449 mg
9. Sodium	<2,400 mg	>4,800 mg
10. Variety	>16 different categories	<7 different categories

* These criteria refer to the number of servings consumed daily. Recommended numbers of servings vary with the energy needs of the individual.

[3] We use a slightly modified version of the HEI. Kennedy et al. (1995) define the "variety" component of the HEI using a survey that asks about food intake over the past several days, whereas the NHANES asks about intake over the past month. We redefined the top and bottom "variety" criteria such that the same proportion of people received a score of 0 and 10 in the NHANES as Kennedy et al. (1995) report for their sample. The cutoffs we use are >33 different food items (for a score of 10) and <14 different food items (for a score of 0).

Perhaps surprisingly, the index does not penalize those with a high sugar intake, which could well contribute to the consumption of excessive numbers of calories. Hence, we will look separately at the determinants of high sweets consumption, where "high sweets" is a variable set equal to one if the person consumed more than 30 sweets per month.

2.1.3 Measures Based on Physical Examinations

Measures based on physical examinations are likely to be the most accurate of the three types of measures, though their interpretation is not without controversy. In what follows, we focus on measures based on Body Mass Index (BMI) (obesity),[4] and on measures of blood cholesterol, and of vitamin and iron deficiencies based on blood and urine samples.

BMI is defined as: weight in grams/(height in meters)^2. Adults with a BMI over 30 are considered to be obese. Defining obesity among adolescents is complicated by the fact that adolescents undergo growth spurts which change their weights and heights disproportionately. One commonly used measure (c.f. Himes and Dietz, 1994) is BMI over the 85th percentile for sex and half-year of age. This measure results in fewer false positives than alternatives based on measures such as skin-fold fat or waist-hip ratios. However, a conceptual difficulty that arises with this definition is that in any given data set, 15% of adolescents would always be found obese. A second problem is that the NHANES surveys used to calculate the cutoffs yield relatively small sample sizes, and cutoffs that bounce around from one age to the next. For example, rather than being smooth, the National Center for Health Statistics (NCHS) growth curves which are based on

[4] In an earlier version of this paper, we also considered determinants of anorexia. We defined a person as anorexic using a BMI cutoff of the 15th percentile for the person's age and gender, in addition to indicators of negative body image (they considered themselves to be overweight, or were trying to lose weight). However, in samples of this size, few people are anorexic and we had little success in modeling the prevalence of this condition.

NHANES I and two earlier surveys, show 90th percentile cutoffs which rise from 21.9 to 23 between the ages of 13.75 and 14.25, and then fall again to 22.4 by age 14.75 (U.S. Dept. of Health, Education and Welfare, 1977). These cutoffs are old, and are due to be updated by NCHS in the very near future.

In this paper we use a fixed cutoff for obesity which is BMI over 27.3 for females and BMI over 27.8 for males. These cutoffs are the 85th percentiles of BMI for young adults between 20 and 29, calculated from NHANES II, which was fielded between 1976 and 1980. While one would expect young adults to be heavier than teens (i.e. that these are conservative cutoffs to use for a sample of teens), we will see below that in the NHANES III, 10% of the teens still exceed these cutoffs.

Blood or urine tests are used to assess the existence and extent of specific micro-nutrient deficiencies, such as essential vitamins and minerals. The relationship between micro-nutrient intake and blood levels of these nutrients is complicated. Because the body can store some vitamins and minerals for a long time, it is not anomalous to find a respondent who has not recently consumed the recommended amount of some vitamin, and yet does not have a deficiency in that vitamin according to blood tests. For example, it can take between three to six years for a deficiency in vitamin B_{12} to become clinically evident (Middleman et al., 1996). Nevertheless, blood tests can provide solid objective evidence of micro-nutrient malnutrition, when properly interpreted.

Appendix Table 1 presents the cutoff values we use to determine vitamin and mineral deficiencies in this paper. These cutoffs, which are taken from a pediatrics textbook (DeAngelis et al., 1999), typically represent blood levels below which the nutrient deficiencies manifest themselves clinically. When possible, the cutoffs used are specific for adolescents.

In addition to providing the information necessary to assess the extent of anemia, the NHANES III allows us to assess the determinants of shortages of essential vitamins A, C, and E.[5] We will focus on a measure that is equal to one if the person is short any of these vitamins, and zero otherwise. Finally, we can examine the level of cholesterol in the blood (serum cholesterol levels). This measure is linked to obesity, and provides an alternative to measuring this important threat to health using BMI.

2.2 Long Term Effects of Poor Nutrition in Adolescents

The nutritional habits of adolescents are important for at least two reasons. First, poor nutritional habits are hard to unlearn as an adult (as the model of O'Donahue and Rabin, in this volume, would predict). Second, poor nutrition can immediately damage a young person's health and the effects can persist into adulthood. The literature on the long term effects of poor nutrition is large, and a comprehensive review is beyond the scope of this paper. Hence, we will focus on some of the most important health consequences of adolescent obesity, high cholesterol, and micro-nutrient deficiencies below. It is not known whether food insecurity has any negative long-term effects, other things being equal.

The long-term effects of obesity among children are relatively well documented. While the majority of obese adults were not obese children, obese children are much more likely to become obese adults. For example, Charney et al. (1976) followed children born between 1945 and 1955

[5] We found little evidence of any shortages of vitamin B_{12} or of calcium, so we do not examine these outcomes.

and found that of the children who were at the 90th percentile of the weight distribution for their sex and age, 36% became obese adults compared to only 14% of average or lighter weight children. Obese adults are known to be at increased risk of many diseases such as diabetes and heart disease. Moreover, the negative effects of childhood obesity may persist even in adults who are no longer obese. Laver, Lee, and Clark (1987) found in a sample of Iowan children that childhood obesity was linked to an increased risk of high cholesterol as an adult.[6]

The long-term effects of micro-nutrient deficiencies vary considerably depending on the vitamin or mineral in question. Interested readers can find a good review from a clinical perspective in any standard pediatrics text, like DeAngelis et al. (1999). Iron deficiency anemia is a particularly pernicious condition, since it can have devastating effects on the school outcomes of children and youths. Even mild iron deficiency is associated with fatigue, shortened attention span, decreased work capacity, reduced resistance to infection, and impaired intellectual performance (U.S. CDC, 1996). About 8% of black Americans carry the sickle cell trait, which places them at much higher risk of anemia than they would face otherwise (Wilson, *et al.*, 1991).

Recently, attention has been focused on the possibly beneficial effects of diets rich in micro-nutrients found in fruits and vegetables rather than on the harmful effects of deficiencies. Epidemiological evidence links diets rich in fruits and vegetables to reductions in risk of stroke, cardio-vascular disease, asthma, osteoporosis, and many specific types of cancer (c.f. Joshipura et al., 1999; Lampe, 1999; Butland, 1999; Palace et al., 1999; Tucker et al., 1999). While the

[6] Anorexia can also have severe long-term consequences on the health of patients, even if they receive appropriate care. The most severe consequence is death (usually due to starvation or suicide) which occurs in 6% of patients. Long-term follow-up studies of surviving anorexics find that about half of the patients reach normal weight, 20% remain underweight, 20% continue to be anorexic, and about 5% become obese (Foster, 1991).

mechanisms for these effects are not well understood, there are many plausible biological reasons for fruits and vegetables to have positive effects. These include stimulation of the immune system, reduction of platelet aggregation, modulation of cholesterol synthesis and hormone metabolism, reduction of blood pressure, and antioxidant, antibacterial, and antiviral effects (Lampe, 1999).

2.3 *Trends Over Time in the U.S.*

A number of authors have documented an increase in the proportion of U.S. children and adolescents who are obese, though the exact trends depend on the definition of obesity used.[7] Figure 1 shows our analysis of trends in obesity using data from the NHANES I, II and III. NHANES I covers the period 1971 to 1974, NHANES II covers the period 1976-1980, while NHANES III covers the period from 1988-1994. For both boys and girls (aged 12-16), the proportion with high BMI decreased slightly between NHANES I and II, but increased greatly between NHANES II and III. Figures 2 and 3 show changes in obesity by race for boys and girls respectively. The time trends are similar for all six race and gender groups, but the much higher incidence of obesity among hispanic men is striking, as is the increasing divergence between whites and either blacks or hispanics.

One interesting hypothesis is that an increase in television watching is behind the increase in obesity among young people (Gortmaker et al., 1996).[8] More generally, Philipson and Posner

[7] Gortmaker et al. (1987) compare measurements of skin fold thicknesses (a standard measure of the amount of body fat) in the NHANES I and NHANES II. They report a 39% increase in the proportion of obese children over the interval of time spanned by these two data sets (1971 to 1980). Ogden et al. (1997) compare data from NHANES I and NHANES III and find that the proportion of obese preschoolers grew from 5 to 10%. The National Center for Health Statistics reports a similar finding for older children (U.S. CDC, 1999).

[8] The prevalence of anorexia has also been increasing over time (U.S. CDC, 1996) but remains low at .5 to 1% of

(2000) conjecture that technological change is responsible for the increase in obesity. They argue that the number of calories consumed has been relatively constant over time, but that technology has led to a reduction in the number of calories expended. Philipson and Posner dismiss the role of information in combating obesity, arguing that "everyone knows how to lose weight". Thus, it will be interesting to ask whether such proxies for information as the education and age of the household head have an effect independent of income in the models of obesity estimated below.

There are relatively few studies that attempt to examine trends in vitamin deficiencies, primarily because relatively few American adolescents suffer from them (c.f. Devaney, Gordon, and Burghardt, 1995). For example, one recent study (Middleman et al., 1996) found only one reported case of vitamin B_{12} deficiency due to inadequate dietary intakes among adolescents (that of a 14-year-old female on a strict vegetarian diet). On average, U.S. adolescents consume more than the U.S. recommended daily allowances of all vitamins. Nevertheless, as we will show below, there are significant numbers of U.S. adolescents who suffer from deficiencies of vitamins A, C, and/or E.[9]

A second reason for the paucity of information about trends in nutritional deficiencies is that the NHANES surveys, which are the main U.S. source of information about nutritional status, have changed the laboratory methods used to track deficiencies. For example, the methods used to evaluate white and red cell counts, serum folate, and serum vitamin C levels were updated in NHANES III, so it is difficult to infer time trends from these surveys (c.f. Raiten and Fisher, 1995 and Wright et al., 1998).

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adolescent girls.

[9] Researchers have also noted declines in calcium intakes among adolescents which are associated with decreases in the consumption of milk (c.f. Albertson et al., 1997 who examine changes between 1980 and 1992). These declines are of concern given that most adolescent girls consume less than 100% of the U.S. recommended daily allowance

Data from other sources suggest that iron deficiency anemia has declined significantly since the late 1960s when several studies found that large number of Americans (especially infants and young females) were iron deficient (c.f. Committee on Iron Deficiency, 1968 and Stockman, 1987). However, Looker et al. (1997) conduct a careful assessment of trends in anemia using data from NHANES II (1976 to 1980) and NHANES III (1988 to 1994), adjusting for differences in the way anemia was measured in these two surveys, and find no change in the incidence of anemia. This study suggests that even trained observers may have difficulty using the NHANES surveys to detect trends in many outcomes.

Data on nutrient intakes and food insufficiency has not been collected consistently either.[10] In view of these data problems, we will confine our own analysis of trends to an examination of obesity which can be measured in the same way using data from NHANES I, NHANES II, and NHANES III.

2.4 U.S. Public Policy and Nutrition

2.4.1 Food and Nutrition Programs

The U.S. government operates a wide variety of food and nutrition programs (FANPs) including the Food Stamp Program (FSP), the National School Lunch Program (NSLP), and the

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of calcium. However, we found little evidence of inadequate blood calcium levels in our NHANES III sample.

[10] In NHANES III, youths were asked about how many times they had consumed a particular type of food (e.g. broccoli) in the past month. In NHANES II, youths were asked about more general categories of food intakes (e.g. fruits and vegetables), and could report consumption in the last day, week, or month (however the person chose to respond). One might expect that asking about detailed categories of foods would lead to higher reported consumption, while asking about foods consumed over the past month would lead to lower reported consumption. Hence, it is not clear a priori how the reported food intakes would be expected to differ between the two surveys.

School Breakfast Program (SBP) among others.[11] Most FANPs were developed with the goal of increasing food consumption among populations who are deemed likely to lack food. For example, the NSLP was established in 1946 in response to nutrition deficiency-related health problems identified among young men being drafted during World War II.

The FSP provides coupons that can be redeemed for food to households with incomes less than 130% of the federal poverty line. There are few restrictions on the types of foods which can be purchased. The NLSP and SBP programs provide free or reduced price meals to children with incomes less than 130% or 185% of poverty, respectively. Meals are designed to offer one-third of the U.S. Recommended Daily Allowances of specified nutrients.

However, as we have discussed, the nature of nutritional risk has changed in the U.S. from a situation in which significant numbers of people suffered food shortages to one in which obesity is prevalent even among the homeless--Luder et al. (1990) examined a sample of homeless shelter users in New York City and found that 39% were obese. This observation raises the question of whether supplying meals (or food coupons) is the most effective way to address the nutritional risks facing the majority of FANP recipients.

In particular, school nutrition programs were roundly criticized in the early 1990s for providing meals that were high in fat and sodium, and low in carbohydrate relative to the recommendations included in the Dietary Guidelines for Americans (USDA and USDHHS, 1995) (c.f. Gordon, Devaney, and Burghardt, 1995). These criticisms led to the Healthy Meals for Healthy Americans Act in November, 1994, which mandated implementation of the Dietary Guidelines in

[11] See Currie (2001) for an overview of U.S. FANPs.

school nutrition programs. Unfortunately, the data available do not allow us to assess the effects of these changes, though NHANES IV (which is currently in the field) will allow such analyses.

Whether or not FANPs improve the quality of the diet, one would expect the availability of these programs to reduce the probability of suffering from food insufficiency. Yet, to our knowledge no studies have been conducted of this issue. We will attempt to fill this gap in the literature in our analyses below.

2.4.2 Educational Interventions

Several studies have looked directly at the question of whether the provision of information through education programs can affect eating patterns. The existing evidence suggests that a wide variety of interventions can be successful in improving young children's eating patterns. For example, Harrell et al. (1998) find that both classroom and individual nutritional education had positive effects on 3rd and 4th grade children in terms of reducing blood cholesterol levels. Glenny et al. (1997) report similar results for family therapy and other interventions aimed at lifestyle modification.

Evaluations of the federal Nutrition Education and Training Program (NET), which provides grants to states who implement nutrition education programs in their schools, have found that it is much easier to improve nutrition knowledge than it is to affect behavior. However, some evaluations of school based programs have shown that children's willingness to try new foods offered in school lunch and the quality of snacks chosen away from home improved, and that children were more likely to consume fruits, vegetables, protein foods, and foods with vitamin A. Poor children have been shown to be more likely to consume diary products and foods with vitamin

C, as a result of school nutrition education programs. Longer programs (e.g. 50 classroom hours or more) have been found to have larger effects on behavior (Contento et al., 1992).

The Personal Responsibility and Work Opportunity Reconciliation Act of 1996 beefed up the nutrition education component of the FSP considerably. Between fiscal year 1997 and 1999, nutrition education spending increased from $32.7 million to a projected $75. million in fiscal year 1999. In response to the Healthy Meals for Healthy Americans Act mentioned above, the USDA has also implemented the School Meals Initiative for Healthy Children to provide nutrition education to both children and food service staff (Hamilton and Fox, 1999).

Thus, public investments in nutrition education have grown considerably in the past few years, and it would be useful to know whether these investments can be expected to "pay off" in the form of improved eating habits. These investments can be contrasted with alternative approaches designed to promote the provision of nutrition information by the private sector.

A number of studies by Pauline Ippolito and Alan Mathios (1990, 1995, 1996) have examined the effects of attempts by both government and advertisers to inform the public about the health benefits of diets low in fat and high in fiber. They argue that government efforts to get this message out during the 1970s were relatively unsuccessful (perhaps because they were underfunded?). But in the mid-1980s, the Federal Trade Commission and the Food and Drug Administration relaxed rules that had prevented food manufacturers from making health claims for their products. Ippolito and Mathios show that after declining very slowly between 1977 and 1985, the consumption of fats and cholesterol fell dramatically between 1985 and 1990, while the consumption of cereals rich in fiber increased. The Nutrition Labeling and Education Act of 1990 is apparently also influencing consumer choices (Ippolito and Mathios, 1993).

2.5 International Comparisons

The evidence on the negative long-term effects of obesity is international in scope. For example, Massberg (1989) reports the results of a forty year follow-up of a sample of Swedes who were obese as children. Forty-seven percent of this sample remained obese. Power, Lake and Cole (1997) provide an overview of similar evidence for the United Kingdom. Both studies also find an elevated mortality risk among adults who were obese as children, even among those who later slimmed down. Similarly, Post et al. (1997) report that Dutch children with a high fat diet were more likely to develop high cholesterol as adults, regardless of whether they remained obese. Gonzalez-Requejo et al. (1995) report that in a sample of Spanish children, those with high fat diets had higher blood cholesterol and lipid levels, which themselves can cause heart damage over time.

Similarly, the available evidence suggests that the increase in the prevalence of obesity over time is not an exclusively U.S. phenomena. Similar findings have been reported in England, particularly in the 27-year-old National Study of Health and Growth (Rona, 1995). For example, Hughes et al. (1997) report that triceps skin-fold measurements from samples of 5 to 11 year old English and Scottish children increased by 7%-8% between 1972 and 1994. This problem is especially acute for minority populations within England, except for Caribbean blacks (Chinn et al., 1998). As in the United States, there is concern that adolescents eat too much junk food: "The average 11-12 year old consumes three portions of crisps, six cans of soft drink, seven bars of chocolate or other biscuits and seven puddings every week," (Shepard and Dennison, 1996).

Other countries have similar problems with increasing trends in child obesity. Barth et al. (1997) report that between 1985 and 1995, the 90th percentile of BMI for children taken from a sample of German pediatric hospitals increased by 5 kg/m^2 for males and 2.5 kg/m^2 for females, a dramatic rise. Seidell (1995) reports that increasing obesity is a problem throughout Europe, but especially in the Southern and Eastern European countries. Even in China, where the trend has been toward improving nutritional status of children, there have been recent increases in obesity prevalence among adolescents (Wang et al., 1991).[12]

As in the U.S., it is rare to find vitamin deficiencies in most European countries. For example, de Bree et al. (1997) review studies of vitamin B12 and folate deficiency in Europe and find that mean intake levels of these nutrients meets or exceeds recommended levels in most European countries. However, just as in the U.S. there is some concern that some pregnant women may not be getting enough extra folate (found in green leafy vegetables) to prevent neural tube defects in their babies.

In Europe, as in the U.S., there is evidence that a substantial number of women may be iron deficient. Hallberg (1995) reviews the literature on iron deficiency status of Europeans. He reports that in Europe, estimates of the prevalence of iron deficiency among menstruating females range between 11% and 45%, depending on the country and also on the particular measure of iron deficiency status used in the study. In general, studies that focus on younger age groups tend to find

[12] Anorexia nervosa is apparently less prevalent in Europe than it is in the United States. For example, using the British General Practice Research Database, Turnbull et al. (1996) estimate that the prevalence of anorexia in England is 4.2 cases per 100,000 population. In a study of nearly 2,500 Austrian, German, and Hungarian college students, Szabo and Tury (1995) report that not one person met the DSM-III-R criteria (the predecessor to the DSM-IV) for a diagnosis of anorexia nervosa. Not surprisingly then, anorexia nervosa has not enjoyed the scholarly interest in Europe that it has enjoyed in the United States.

higher prevalence rates. If these studies are accurate, they indicate that iron deficiency is a much greater problem in Europe than it is in the United States.[13]

3. Nutrition as an Investment in Human Capital Formation

Grossman (1972) offers a model of health as a form of human capital which is "produced" by investing in certain activities. Health is treated as a durable stock variable which depreciates with age, and which can be improved by investing in health producing activities such as adopting a healthy diet. In his model, a consumer's utility depends on the stock of health rather than on the consumption of any of the investment goods per se. However, this restriction can easily be relaxed to allow consumers to obtain utility from the consumption of "investment" goods (e.g. hamburgers) as well as from health outcomes.

Consumers choose a stream of health investments with the aim of maximizing lifetime utility. In making these choices they are constrained both by what they know about the production of health capital (the human capital production function), and by their budget constraints. The key equilibrium condition in Grossman's model is that consumers choose their stream of investments to equate the marginal cost of the investment (which includes the lost utility from choosing carrots over cookies) with the present value of the marginal benefit of that investment.

Grossman's model generates an important prediction about patterns of health stocks and investments over the life cycle. If the rate of depreciation of health stocks increases with age, then health investments will increase with age, as long as the elasticity of the marginal efficiency of

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[13] However, Hallberg points out that some of the prevalence studies are methodologically flawed because they do not account for the fact that measurements of iron deficiency spuriously rise if the subjects have a cold (or other insults to the immune system). Accounting for this in one of the studies he reviews reduces the prevalence estimate by half.

health investment is less than one.[14] Since children and adolescents have the highest stock of health capital and the lowest rates of depreciation, the model predicts that conditional on the resources and information available to them, they will be less likely than adults to choose a healthy diet. As a practical matter, the food choices of young children may be determined largely by what their parents provide for them to eat. Thus, one might well expect adolescents, who enjoy increasing autonomy from their parents, to make the worst food choices.

Of course poor food choices in adolescents are a matter of concern largely because they may forecast a lifetime of poor eating habits. An explanation for the persistence of poor eating habits that is consistent with the Grossman model is that food choices are determined largely by informational and resource constraints rather than by health depreciation rates, and that these constraints show persistence over the lifecycle (that is, the children of the poor and uneducated are more likely to be poor and uneducated). A second possible explanation (c.f. O'Donahue and Rabin, this volume) is that teenagers rationally decide that they can afford to subsist on hamburgers and french fries for the moment, but underestimate how difficult it will be to lose their taste for these foods later on.

These considerations suggest estimation of an input demand function, or health outcome function of the following form:

(1) $\text{OUTCOME} = a_0 + a_1\text{INFO} + a_2\text{RESOURCE} + a_3X + e,$

where INFO represents variables that affect the information available to the decision maker,

[14] That is, a 10% increase in health investment improves health by less than 10%.

RESOURCE is a vector of variables affecting resource constraints, X is a variable of other variables that may affect the outcome in question (such as gender), and e is an error term that is assumed to be uncorrelated with the other right hand side variables in the model.

4. Data

Our main source of data is the NHANES III. This nationally representative survey was conducted between October 1988 and October 1994, and oversampled blacks and Mexican-Americans. The NHANES is unique in that it combines demographic information, data from a standard clinical exam conducted by doctors (including blood and urine tests), questions about dietary intakes, information about participation in the FSP, NLSP, and SBP, and questions on food insecurity. Our sample includes all those who were aged 12 to 16 at the time of the survey, and who had non-missing explanatory variables.[15] These restrictions yield a sample of 1358 youths.

Means of the outcome variables we consider are given in Table 1, for everyone, and by gender, race, and ethnicity. Precise definitions of these variables are given in Appendix Table 1. These means indicate that, as discussed above, anemia is rare, and is found primarily among black girls. However, vitamin deficiencies are surprisingly common, affecting 9% of the sample. It is interesting that hispanics are less likely than blacks or whites to suffer from these deficiencies. High BMI (obesity) is also common, especially among blacks and hispanics. In the table we show 100 minus the Healthy Eating Index (so that high numbers for any of our outcomes are always "bad").

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[15] Unfortunately, older adolescents were asked somewhat different questions (they completed the adult questionnaire rather than the youth questionnaire), and it proved impossible to integrate them into the sample. For example, questions about food frequencies were asked only to the 12 to 16 year old sample.

This measure of the composition of the diet indicates that blacks have worse diets than whites or hispanics on average, but that the differences are not large. Blacks are also more likely than whites to have high sweets consumption, while hispanics are less likely. Finally, blacks and hispanics are much more likely than whites to report that they suffer from food insecurity: The fractions are 4, 12, and 9% for whites, blacks and hispanics, respectively.

The second half of Table 1 examines the relationships between these variables. If for example, it was true that those with vitamin deficiencies also usually suffered from food insecurity, then it would not be necessary to examine the two measures separately. Instead Table 1 shows that while there are nutritional problems that tend to be found together, our measures of nutritional quality do seem to measure different dimensions of "misnutrition". Moreover, measures of deficiencies and food insecurity are often related to over-consumption of calories and sweets. For example, among those who are short vitamins, 4% are anemic and 6% are food insecure, but 10% have high BMI and a surprising 28% consume too many sweets. Thus, for many youths, being vitamin deficient is less a matter of consuming too little food than a matter of consuming the wrong types of food. The results for food insecurity are also striking. Of youths suffering from food insecurity, 10% have high blood cholesterol levels, 18% have high BMI, and 30% consume too many sweets. Thus, although these youths do not always know where their next meal is coming from, on average they are consuming too much sugar and fat, and too many calories overall.

Means of the explanatory variables we consider are shown in Table 2, arranged by whether or not respondents had one of four types of nutritional problem. Of the potential explanatory variables that we observe, education of the head is the most obvious indicator of the extent of nutrition "information" that is likely to be available to the household. The age of the head may also be important if there are cohort effects in the ability of household heads to assimilate new information and pass it on to their children. Immigrant parents may also bring with them different information about foods than native born parents. Urban residents may have greater exposure to new information, as well as to a wider array of products.[16]

An additional measure that we consider is the youth's exposure to television, measured by the number of hours of television he or she watched on the previous day. While the decision to watch television is clearly an endogenous choice, it also affects the youth's store of nutrition information via passive exposure to advertising messages. These messages generally promote the consumption of sweet, high-fat food and drink. And evidently television watching will reduce the number of calories expended if it takes the place of less sedentary activities.

The most natural measure of resources is household income, and an indicator equal to one if the households income is below 1.3 times the poverty line is included in Table 2. This is the cutoff for free school meals and for participation in the Food Stamps Program. Additional indicators of household resources include whether the family is female headed, and indicators for household size. Participation in food and nutrition programs can also be expected to increase the resources available to the household. However, because the families who select into these programs are likely to differ

[16] On the other hand, a large literature on urban food prices argues that people in poor inner-city neighborhoods pay more for food than those in more affluent neighborhoods. This literature suggests that people in poor urban neighborhoods may find it prohibitive to purchase things like fresh fruit and vegetables. Hayes (1999) reviews this literature and argues that most of it is flawed by the use of "samples of convenience" rather than random samples. Using data from a stratified random sample of stores in New York City, he finds no differences in food prices between inner-city and other areas. The USDA recently reported that 90% of the poverty population lives in an area with at least one supermarket, and that supermarkets in poor areas do not charge more than those in other areas (Mantovani, 1997).

from families who do not, one may well find that participation is associated with poorer nutritional outcomes, even if the programs have positive effects. Finally, we have included maternal BMI as an indicator of the parent's health status (and thus of the child's endowment).[17]

Table 2 provides an initial look at whether these explanatory variables appear to be related to nutritional outcomes. Youths with poorer nutritional outcomes come, on average, from households with poorer, younger, less educated, and often female heads. These differences are particularly large when we compare youths who suffer from food insecurity with other youths. Misnourished youths also tend to watch more television than others. For example, youths with high BMI typically watched almost one hour more of TV in the previous evening than other youths. Youths from households that use food stamps are more likely to be short vitamins, have higher BMI, and are twice as likely to suffer food insecurity than other households. However, they do score better on the HEI. The (unconditional) differences in the use of school nutrition programs show similar patterns. Thus, although participation in food and nutrition programs may narrow gaps between participants and non-participants in nutritional outcomes, it does not appear to close them.

5. Results

5.1 Baseline Estimates

Estimates from baseline models of the form (1) appear in Table 3. Increased education of the head is associated with a reduced incidence of high BMI, better overall diet quality, and lower

[17] In earlier work we also included father's BMI as well as indicators equal to one if either parent had high blood pressure, stroke, or diabetes. We found that it was difficult to sort out the separate effects of these variables as they were all positively correlated. An additional problem was that father's BMI is often missing. Hence, we focus only on maternal BMI.

sweets consumption, as well as with a reduced probability of food insecurity. The estimates indicate, for example, that youths in households with college educated heads would be 4 percentage points less likely to be obese than those with high-school educated heads. There is little evidence of cohort effects, though older heads are somewhat less likely to be food insecure. Being urban reduces the probability of being short vitamins, but also increases the probability of having high BMI. Children of immigrants are more likely to have high blood cholesterol, but also have healthier diets overall, as measured by the HEI.[18]

It is striking that while poverty is associated both with higher blood cholesterol levels, and higher BMI, it is not a significant determinant of either of our deficiency measures (short vitamins or anemia). Poverty is associated with food insecurity however, as is female headship, and a larger household size. Higher maternal BMI is associated with higher adolescent BMI, a higher probability of being short vitamins and poorer overall diet quality, as one might expect. However, it may be surprising to see that youths with mothers who have high BMI consume fewer sweets, perhaps in an attempt to avoid obesity themselves.

There are also some significant differences by race, gender, and ethnicity which are generally consistent with the differences shown in Table 1. Males have worse overall diet quality than females and are more likely to report food insecurity. However, females are more likely to suffer from anemia, high blood cholesterol and high BMI. There are many potential explanations for these differences, including differences in teenage metabolism between boys and girls, and

[18] The finding on immigrant status complements the conclusions of a recent National Research Council/Institute of Medicine (1998) report on the health status of immigrant children which concluded that despite poorer economic status, the health of immigrant children tends to be better than that of native born children, and to decline with assimilation.

differences in socioeconomic status. Blacks have poorer quality diets and consume more sweets. Hispanics have better diet quality and are less likely to be short vitamins. They also consume fewer sweets. These racial and ethnic differences are explored in further detail in Table 6 below.

In summary, if we group our dependent variables into those representing deprivation, obesity, and overall diet quality, Table 3 supports the following generalizations: First, both education and income have important effects on our outcome measures. The effects of education are always positive (where they are significant), while effects of poverty are always negative. Second, education affects some outcomes which do not seem to be sensitive to income, and vice versa. To be more specific, measures of household resources are important determinants of food insecurity, but have little effect on actual nutritional deficiencies such as anemia and vitamin deficiencies. Information, as proxied by the education of the household head, plays an important role in the determination of overall diet quality, prevention of obesity, and in the reduction of food insecurity. Other variables such as urbanicity, immigrant status, and maternal BMI also play significant roles in the determination of some nutritional outcomes, but it is difficult to determine whether this reflects information or resource effects, or both.

5.2 *Effects of TV, and Food and Nutrition Programs*

The estimated effects of two sets of potentially endogenous explanatory variables are shown in Table 4. Panels A and B report estimates from two separate sets of regression. In the first, the variables representing hours of television watching were added to models identical to those shown in Table 3, while in the second panel, variables indicating participation in food and nutrition programs were added to these models. For the sake of brevity, only the coefficients on the added variables are shown.

5.2.1 Effects of TV

Excessive TV watching is associated with some very negative effects on diet quality. While we found no statistically significant effects among youths who reported watching 2 to 4 hours of television the previous evening, those who had watched 5 or more hours were more likely to be short vitamins, had poorer overall diet quality, and higher BMI than other youths. On the other hand, these youths consumed fewer sweets (although this effect is only marginally statistically significant) and were less likely to report food insecurity.

These observations are consistent with those of Gortmaker *et al.* (1996). There are many ways that TV watching can affect obesity. It is possible that the informational content of the programming and especially of the advertising plays a role, by enticing people to eat junk food. Alternatively, one can view advances in TV technology as something that makes this sedentary form of recreation more attractive than other, more active, ways that people could spend their leisure hours.

Of course, the correlations we find do not prove that television watching causes poor dietary habits or obesity. It is possible that both are caused by some third, unobserved factor such as a low value attached to health, or a lack of information about healthy lifestyles. Without an exogenous source of variation in the data, it will be difficult to demonstrate a causal linkage.

5.2.2 Effects of Food and Nutrition Programs

The second panel of Table 4 contains initial estimates of the effects of participation in food and nutrition programs on nutritional outcomes. These estimates may also be biased by unobserved variables. For example, if youths in observationally similar non-participating households are actually less needy, then these estimates may be biased towards finding negative or nil effects of participation. On the other hand, if youths in observationally similar households do not participate because they lack information about the programs, or because their parents place less value on good nutrition, then these estimates will overstate the positive effects of the programs.

In any case, the estimates suggest that the Food Stamp Program has little effect on measures of deficiencies, obesity, or dietary quality, although it is associated with reductions in food insecurity. School lunch is associated with a lower prevalence of anemia, which is encouraging given that these meals aim to provide iron. School breakfast and lunch are however both associated with higher cholesterol levels, though school breakfast is also associated with slightly better overall diet quality.

Table 5 lays out the results of an attempt to address the endogeneity of school nutrition program participation using difference-in-differences methods. The identification in Panels A and B comes from the fact that while children may be income-eligible for school meals year round, the meals are only provided while the schools are in session.[19] Thus, after controlling for the main effects of eligibility and of school being in session, the interaction term can be interpreted as measuring "exposure" to school meals. Panel A measures exposure to free school meals by defining the eligible as those with incomes less than or equal to 1.3 times the federal poverty line. Panel B measures exposure to free or reduced price meals by using 1.85 times the federal poverty line as the income eligibility cutoff.

Panel A suggests that exposure to free school meals improves the overall quality of the diet, although it has no significant effect on our measures of deficiencies (anemia and being short vitamins), obesity, or food insufficiency. The magnitude of the improvement is enough to offset the negative effect of simple eligibility (i.e. poverty) on diet quality. Panel B indicates that in addition to improving overall diet quality, exposure to free or reduced price school meals reduces blood cholesterol (which is increased by poverty) and sweets consumption. Since the difference between Panels A and B is that the latter includes children with incomes between 1.3 and 1.85 times the federal poverty line in the eligible group, these results suggest that the reduction in cholesterol and sweets intake is concentrated in this group. These generally positive results of exposure to school meals suggest that despite the fact that these meals have been found to be high in cholesterol and sodium, they are healthier than the meals that youths would eat in the absence of school meal programs.

[19] Some youths may participate in The Summer Food Service Program. This program provides meals similar to those of the NLSP or SBP during the summer months and is often run through schools. However, the caseload is small relative to the NLSP or SBP. In the summer of 1998, the program served 2.3 million children per day compared to 14.7 million children per day who participated in the NLSP and 6.8 million who participated in the

5.3 Differences by Race and Ethnicity

As noted above, we estimated all of our models separately by race and ethnicity. These estimates are shown in Table 6. Note that since blacks and hispanics were over-sampled in NHANES III, we actually have larger samples of these groups than of whites. The effects of information and resources differ substantially between the three groups. For example, among whites, education reduces the incidence of obesity and improves the overall quality of the diet. Among hispanics, education reduces the probability of being short vitamins and of being food insecure, but has a small positive effect on the incidence of high blood cholesterol. Among blacks, education of the head has no statistically significant effects. Similarly, we find evidence of cohort effects only for hispanics--for them, increases in the age of the household head are associated with higher cholesterol and sweets intake, but also with a lower probability of food insecurity. Urban residence is associated with a higher probability of anemia among blacks, but with lower probabilities of being short vitamins and higher overall diet quality among hispanics. Being an immigrant is associated with higher quality diets among blacks and hispanics (though hispanic immigrants are also more likely to have high cholesterol and high BMI), but with vitamin deficiencies among whites.

Turning to the effects of resource constraints, poverty increases the probability of high cholesterol and high BMI among whites, and is associated with worse overall diet quality. Among hispanics, poverty is also associated with high cholesterol as well as with food insecurity. However, poverty is actually associated with a lower probability of obesity among hispanics. Remarkably,

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SBP during the 1997-98 school year.

among blacks, poverty has no effect on any outcome except food insecurity.

The contrast between the effects of income on BMI among whites and hispanics is suggestive of the Jeffrey *et al.* (1991) result that obesity tends to rise with income in poor countries, and to fall with income in rich countries. A possible explanation is that in rich countries, where most jobs are sedentary, it takes money and leisure to exercise, so thinness becomes a status symbol. In poor countries where many people engage in manual labor, fatness is the status symbol. Many hispanics may have brought this attitude with them from their countries of origin.

Among both blacks and hispanics, female-headedness is an important predictor of problem diets--black youths in these households are more likely to be short vitamins and also to have high BMI. Hispanics in these households are more likely to have high BMI, and high cholesterol, and to have diets of worse overall quality. Among whites, female-headedness predicts food insecurity, but is not related to the other outcome measures. Finally, it is interesting that larger white households are less likely to experience food insecurity, while larger hispanic households are more likely to be food insecure.

To summarize, the main conclusion to be drawn from Table 6 is that most of our explanatory variables have quite different effects on whites, blacks and hispanics. Differences between whites and hispanics in the effects of education and income are particularly striking. Essentially, education of the head appears to improve dietary quality and lower BMI only among whites. Among hispanics, education is associated with less deprivation, but also with less healthy diets. Similarly, poverty increases BMI among whites, but decreases it among hispanics. Education and income have no significant effect on deficiencies or quality of diet among blacks, though they do not impact food security.

5.4 *Differences by Gender*

Table 7 shows the results of the regressions similar to those of Table 3, except that they are estimated separately for boys and girls. There is some evidence that both information and resources are needed to explain the pattern of outcomes. Increasing education of the household head improves diet quality for both boys and girls, but reduces the proportion with high BMI among girls only. For boys, increased education of the household head reduces sweets consumption and food insecurity. Girls from poor families have higher blood cholesterol, worse dietary quality, and a higher probability of food insecurity than girls from richer families. Among boys, poverty is associated with a higher incidence of vitamin deficiencies and high BMI, but not with worse dietary quality. Overall, this pattern of results suggests that while there are some differences in the effect of these covariates for boys and girls, education generally improves nutritional status and poverty decreases it. Since the covariates do not differ markedly among boys and girls, and the effects of these covariates on nutritional outcomes also do not differ markedly, the most plausible explanation for differences in outcomes across gender are biological and metabolic differences in the rate of maturation in adolescence for boys and girls.

5.5 *Determinants of Trends in Obesity over Time*

Using the NHANES I, II, and III separately, Table 8 compares coefficients from a regression of obesity status (high BMI) on a limited set of covariates that are available in all three data sets. For all three data sets, increasing education of the household head is correlated with lower obesity prevalence, but the effect is largest in the NHANES III, the most recent data set. Urban children are 3 percentage points more likely to be obese in the NHANES III, but not in the other data sets. Immigrant children are less likely to be obese in the NHANES II and III, but not in NHANES I. These patterns on the effect of urbanity and immigration status are likely due to demographic shifts in these populations across time. Larger households tend to have lower obesity prevalence in all three data sets, with the largest absolute effect in the NHANES III. Children from poor households are more likely to be obese than children from other household in the NHANES III, but not in NHANES I and II. Females are three to four percentage point more likely to be obese than males in all three data sets, with a one percentage point increase in the gap in the NHANES III over the other two time points. Finally, despite the racial differences present in Figures 2 and 3 in obesity prevalence, the regressions reveal no significant differences by race, except for hispanics in the NHANES II.

Overall, these results suggest a structural break in the relationship between the covariates and obesity prevalence occurred between NHANES II and III. In particular, the importance of both information (education of household head) and resources (poverty) in predicting obesity increased in the NHANES III over the other two data points.

6. Conclusions

We find that although many youths suffer from nutrient deficiencies (either anemia or vitamin deficiencies) these conditions are not generally sensitive to measures of resource constraints, and hence are unlikely to be due solely to a lack of food. The only exception is in black female-headed households, where youths are more likely to be vitamin deficient. Hence, as discussed in the introduction, most U.S. youths who suffer nutritional deficiencies are "misnourished" rather than malnourished, and in fact often consume too many rather than too few calories.

These results suggest that programs like Food Stamps which provide additional access to food but do not attempt to alter the composition of the diet may have smaller effects on important nutritional outcomes such as overall diet quality than school meal programs which offer specific types of food. Our difference-in-difference estimates do in fact suggest that school nutrition programs lead to healthier diets than would otherwise be consumed. The recent reforms to the program are likely to enhance this effect.

A second noteworthy finding is that the determinants of food insecurity appear to be quite different than the determinants of nutritional deficiencies, obesity, or dietary quality. In particular, resource constraints are more strongly linked to food insecurity than to the other nutritional outcomes that we examine. It is also remarkable that we find little evidence that access to school nutrition programs relieves food insecurity, at least in our difference-in-difference models. These findings suggest that it is somewhat simplistic to equate food insecurity with hunger, as is often done. Food insecurity appears to be a more complex problem, with strong relationships to social phenomena like female-headedness. More generally, our results suggest that it is worthwhile to examine a range of indicators that capture different aspects of nutritional status.

Although it is difficult to directly test the hypothesis that information or technology matter, we find several pieces of evidence consistent with this idea. First, education of the head has a consistently beneficial effect in models of obesity, diet quality, and food insecurity. It is worth noting however, that we find these effects predominantly among whites. Secondly, the age of the head matters in hispanic families, with families with older heads having poorer quality diets. This type of cohort effect is consistent with a slow diffusion of new information about nutrition through the population over time, with younger heads being more receptive to new ideas than older heads. Indeed, we find that the effect of the household head's education level on obesity prevalence increases in size in the most recent data set we examine. Third, we find that TV viewing has consistently negative effects on all our outcome measures. This could be due either to the content of the programming and advertising (i.e. advertisements for soft drinks and potato chips), or to the fact that TV technology encourages many people to spend their leisure hours in sedentary activity.

While the preceding summary emphasizes instances in which our explanatory variables have statistically significant effects, it is striking that in many cases our models have relatively little explanatory power. This finding suggests that poor nutrition is a problem for American youths, regardless of family background. The very pervasiveness of the problem suggests that it is unlikely to be entirely due to a lack of household resources, and that broad-based policies designed to alter the composition of the diet, either through the provision of information (e.g. through nutrition labeling), or through direct provision of healthy food (as in the revised school lunch program), should be encouraged.

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Appendix Table 1: Definitions of Outcome Variables

Sufficient Food
When asked whether they had "enough food to eat, sometimes not enough to eat, or often not enough to eat", respondent answered that they had enough food to eat.

Dietary Intakes:
Healthy Eating Index described in text.
High Sweets: reported consuming more than 30 sweets per month.

Measures based on Physical Examination and Laboratory Measures
Anemia: For age 12, cutoffs were hemoglobin < 11.5 g/dL and hematocrit lt 35%. For > 12, cutoffs were hemoglobin < 12 g/dL and hematocrit lt 37%.
High Blood Cholesterol: Serum cholesterol gt 5.44 nmol/L.
Short Vitamin C: < 11.4 mmol/L.
Short Vitamin A: < 1.05 umol/L.
Short Vitamin E: < 11.6 umol/L.
High BMI: > 27.3 for females and > 27.8 for males.

Table 1a: Means of Outcome Variables, and Fraction with One Problem Who Also Have Another

Panel A: Means	All	Male	Female	White	Black	Hispanic
Anemia	.035	.005	.069	.019	.122	.019
Short Any Vitamin (A,C,E)	.089	.100	.078	.093	.107	.063
High Blood Cholesterol	.048	.032	.065	.032	.075	.099
High BMI	.089	.066	.113	.075	.134	.146
100 - Healthy Eating Index	40.3 (.420)	44.5 (.563)	35.7 (.563)	39.9 (.780)	43.8 (.670)	38.8 (.864)
High Sweets	.243	.239	.248	.232	.324	.147
Food Insecure	.055	.062	.048	.038	.115	.092
# Observations	1358	622	736	371	527	402

Panel B: Fraction with One Problem Who Also Have Another	Anemic	Short Vitamins	High Chol.	High BMI	100-HEI	High Sweets	Food Ins.
Anemic	1	.096	.053	.104	39.4	.241	.089
Short Vitamins	.038	1	.016	.102	43.5	.283	.062
High Blood Cholesterol	.039	.030	1	.183	39.3	.168	.121
High BMI	.041	.103	.098	1	41.5	.111	.110
HEI <= 25th percentile	.032	.110	.032	.103	60.9	.235	.083
High Sweets	.035	.104	.033	.040	38.1	1	.069
Food Insecure	.057	.100	.105	.176	43.8	.302	1
# Observations	100	150	81	172	341	353	133

Note: Standard errors in parentheses. Means are calculated using sampling weights.

Table 2: Means of Explanatory Variables

	Short Vitamins		High BMI		100-HEI		Food Insecure	
	NO	YES	NO	YES	< 25	> 75	NO	YES
Education Head	12.6	11.95	12.6	11.1	12.0	12.8	12.6	10.1
	(.086)	(.217)	(.086)	(.195)	(.144)	(.178)	(.083)	(.282)
Age Head	40.4	39.0	40.4	39.3	39.6	40.9	40.4	37.9
	(.205)	(.619)	(.203)	(.666)	(.406)	(.363)	(.207)	(.457)
Urban	.486	.347	.470	.515	.394	.554	.473	.484
	(.014)	(.039)	(.014)	(.038)	(.027)	(.027)	(.014)	(.043)
Immigrant	.149	.127	.148	.137	.148	.170	.147	.142
	(.102)	(.027)	(.010)	(.026)	(.019)	(.020)	(.010)	(.030)
Income < 1.3*	.288	.382	.276	.498	.333	.241	.266	.811
Poverty	(.013)	(.040)	(.013)	(.038)	(.026)	(.023)	(.0126)	(.034)
Female Head	.210	.287	.202	.367	.250	.178	.190	.671
	(.012)	(.037)	(.012)	(.037)	(.023)	(.021)	(.011)	(.041)
Household Size	4.68	4.46	4.68	4.44	4.60	4.80	4.64	4.98
	(.044)	(.125)	(.044)	(.118)	(.094)	(.077)	(.043)	(.150)
Mother's BMI	25.7	26.9	25.6	28.1	26.3	24.6	25.7	26.5
	(.160)	(.502)	(.158)	(.522)	(.298)	(.288)	(.160)	(.520)
Hours TV	2.91	3.32	2.87	3.71	3.06	2.55	2.94	3.01
	(.052)	(.154)	(.053)	(.143)	(.103)	(.098)	(.052)	(.162)
Food Stamps	.158	.209	.148	.312	.163	.121	.152	.341
	(.010)	(.033)	(.010)	(.035)	(.020)	(.018)	(.010)	(.041)
# Times School	3.14	3.56	3.16	3.39	3.56	2.92	3.17	3.42
Lunch/Week	(.063)	(.167)	(.063)	(.161)	(.114)	(.119)	(.062)	(.177)
# Times School	.484	.508	.451	.840	.533	.419	.462	.895
Breakfast/Week	(.040)	(.113)	(.039)	(.134)	(.077)	(.069)	(.039)	(.156)
# Observations	1208	150	-1186	172	341	340	1225	133

Notes: Standard errors in parentheses. Means are computed using sample weights.

Table 3: Baseline Estimates

	(1) Anemia	(2) Short Vitamins	(3) High Chol.	(4) High BMI	(5) 100-HEI	(6) High Sweets	(7) Food In-secure
Education Head	-.0003	-.004	.002	-.010	-.518	-.013	-.007
	(.144)	(1.496)	(.761)	(3.48)	(3.39)	(2.801)	(2.93)
Age Head	.001	-.002	-.0002	-.001	-.089	-.0006	-.002
	(1.395	(1.536)	(.256)	(1.28)	(1.56)	(.385)	(1.85)
Urban	.004	-.033	-.002	.036	-2.02	-.024	.006
	(.418)	(1.994)	(.201)	(2.29)	(2.40)	(.965)	(.486)
Immigrant	-.004	.026	.038	-.031	-2.95	.048	-.029
	(.203)	(.903)	(1.748)	(1.08)	(1.98)	(1.01)	(1.29)
Income<1.3* Poverty	-.003	.020	.059	.034	1.60	-.047	.071
	(.214)	(.939)	(3.804)	(1.65)	(1.49)	(1.49)	(4.45)
Female Head	.004	.013	-.014	.022	.120	-.011	.113
	(.278)	(.556)	(.848)	(.976)	(.103)	(.337)	(6.50)
Household Size	.002	-.005	-.007	-.011	-.294	.009	.014
	(.618)	(.942)	(1.619)	(2.14)	(1.05)	(1.07)	(3.24)
Mother's BMI	.001	.025	.005	.055	2.43	-.064	-.007
	(.101)	(1.75)	(.434)	(4.01)	(3.37)	(3.02)	(.681)
Male	-.061	.019	-.031	-.046	8.93	-.012	.002
	(6.22)	(1.20)	(2.726)	(3.02)	(11.24)	(.516)	(1.85)
Black	.098	-.005	.026	.007	2.99	.109	.002
	(6.46)	(.198)	(1.445)	(.313)	(2.45)	(3.04)	(.090)
Hispanic	-.005	-.055	.033	.032	-.420	-.113	.011
	(.279)	(1.85)	(1.526)	(1.09)	(.278)	(2.57)	(.504)
Other	.018	-.047	-.002	-.032	3.98	.097	-.001
	(.710)	(1.16)	(.073)	(.808)	(1.95)	(1.61)	(.038)
Constant	.003	.176	.044	.175	41.09	.567	.099
	(.058)	(2.32)	(.781)	(2.36)	(10.57)	(4.98)	(1.72)
R-squared	.069	.021	.033	.058	.130	.032	.121

Notes: T-statistics in parentheses. There were 1358 observations in all regressions.

Table 4: Effects of TV and Nutrition Programs

	(1) Anemia	(2) Short Vitamins	(3) High Chol.	(4) High BMI	(5) 100-HEI	(6) High Sweets	(7) Food In-secure
<u>A: TV Watching</u>							
2-4 hours	.008	.007	-.007	.015	.489	-.001	-.018
yesterday	(.752)	(.427)	(.549)	(.919)	(.568)	(.043)	(1.38)
over 5 hours	-.014	.077	.001	.086	3.92	-.071	-.051
yesterday	(.838)	(2.93)	(.026)	(3.36)	(2.92)	(1.79)	(2.58)
R-squared	.070	.027	.034	.066	.135	.034	.125
# Observations							
<u>B: Food and Nutrition Programs</u>							
Food Stamps	.001	-.009	.018	.034	-1.04	-.069	-.064
	(.059)	(.327)	(.942)	(1.32)	(.770)	(1.73)	(3.18)
School Breakfast	-.021	.036	-.003	.036	-2.98	.025	.033
1-4 times/week	(.928)	(.984)	(.109)	(1.03)	(1.62)	(.456)	(1.21)
School Breakfast	.015	-.027	.057	.051	-3.48	.044	-.0002
5 times/week	(.739)	(.843)	(2.39)	(1.61)	(2.10)	(.905)	(.010)
School Lunch	-.045	.007	.039	-.011	-1.42	.015	.007
1/4 times/week	(3.08)	(.303)	(2.27)	(.464)	(1.20)	(.443)	(.403)
School Lunch	-.020	.013	-.020	-.003	-.581	.007	-.019
5 times/week	(1.62)	(.669)	(1.34)	(.160)	(.569)	(.236)	(1.29)
R-squared	.077	.023	.047	.051	.136	.034	.131

Notes: T-statistics in parentheses. All models include all of the variables listed in Table 3, and 1358 Observations.

Table 5: Difference-in-Difference Evaluations of the Effects of School Nutrition Programs

	(1) Anemia	(2) Short Vitamins	(3) High Chol.	(4) High BMI	(5) 100-HEI	(6) High Sweets	(7) Food In-secure
A: Eligible for Free School Meals							
Eligible	-.019	-.004	.090	.050	5.82	.019	.086
	(.847)	(.099)	(.027)	(1.39)	(3.12)	(3.51)	(3.11)
School in	-.033	.010	-.022	-.021	1.83	.086	.006
Session	(2.39)	(.477)	(1.39)	(.972)	(1.64)	(2.64)	(.352)
Eligible*	.025	.026	-.038	-.020	-5.94	-.090	-.023
in Session	(.988)	(.627)	(1.25)	(.496)	(2.86)	(1.47)	(.728)
R-squared	.073	.020	.038	.061	.133	.037	.122
B: Eligible for Reduced Price School Meals							
Eligible	-.010	-.008	.096	.028	2.83	.068	.078
	(.465)	(.237)	(3.99)	(.857)	(1.70)	(1.40)	(3.16)
School in	-.050	.011	-.010	-.024	1.46	.128	.006
Session	(1.99)	(.458)	(.535)	(1.03)	(1.18)	(3.54)	(.332)
Eligible*	.011	.015	-.054	-.004	-3.09	-.159	-.014
in Session	(.472)	(.407)	(1.99)	(.124)	(1.64)	(2.90)	(.515)
R-squared	.073	.020	.040	.059	.128	.042	.122

Notes: See Table 4. These models did not include the indicator for income < 1.3 and poverty since this is the same as eligibility

Table 6: Differences in the Effects of Information and Resources by Race and Ethnicity

	(1) Anemia	(2) Short Vitamins	(3) High Chol.	(4) High BMI	(5) 100-HEI	(6) High Sweets	(7) Food In-secure
White							
Education Head	.002	-.002	.002	-.016	-.950	-.011	-.004
	(.554)	(.257)	(.431)	(2.97)	(3.14)	(1.22)	(.969)
Age Head	.001	-.004	-.001	-.003	-.137	-.002	-.001
	(1.08)	(1.46)	(.926)	(1.20)	(1.19)	(.640)	(.810)
Urban	-.012	-.045	-.020	.042	-2.52	-.033	.006
	(.820)	(1.38)	(1.03)	(1.50)	(1.63)	(.703)	(.319)
Immigrant	.033	.145	.009	-.088	-2.70	.014	-.034
	(.904)	(1.86)	(.189)	(1.31)	(.729)	(.127)	(.733)
Income < 1.3* Poverty	.0002	.048	.045	.119	.372	-.038	.027
	(.013)	(1.07)	(1.64)	(3.08)	(1.75)	(.576)	(1.01)
Female Head	.001	-.020	-.010	-.056	-1.22	.019	.209
	(.041)	(.394)	(.326)	(1.27)	(.507)	(.253)	(6.86)
Household Size	.004	-.012	.005	-.022	-.651	.024	-.020
	(.685)	(1.02)	(.629)	(2.09)	(1.12)	(1.37)	(2.77)
Mother's BMI	-.001	.002	.000	.006	.268	-.007	-.001
	(.914)	(.742)	(.086)	(2.26)	(1.90)	(1.63)	(.329)
Male	-.040	.023	-.018	-.057	8.73	-.039	.015
	(2.79)	(.762)	(.955)	(2.15)	(5.98)	(.864)	(.818)
Constant	-.012	.250	.048	.344	49.72	.577	.010
	(.165)	(1.61)	(.508)	(2.55)	(6.72)	(2.54)	(.107)
R-squared	.033	.035	.020	.105	.178	.021	.186
Black							
Education Head	-.006	-.002	-.0004	.002	-.150	-.015	.001
	(1.01)	(.369)	(.076)	(.352)	(.490)	(1.61)	(.200)
Age Head	.0004	.002	.0004	.001	-.037	.002	-.001
	(.252)	(1.27)	(.278)	(.663)	(.480)	(.643)	(-.775)
Urban	.072	.045	.005	.042	.317	-.008	-.016
	(2.52)	(1.63)	(.198)	(1.41)	(.231)	(.186)	(.574)
Immigrant	-.050	-.027	-.026	-.045	-6.04	-.060	.089
	(.944)	(.515)	(.576)	(.800)	(2.34)	(.752)	(1.69)
Income < 1.3* Poverty	.015	.019	.010	-.042	-.229	-.025	.150
	(.489)	(.625)	(.394)	(1.27)	(.152)	(.535)	(4.87)
Female Head	.023	.070	-.032	.065	-2.37	-.002	-.033
	(.742)	(2.34)	(1.26)	(2.03)	(1.60)	(.037)	(1.09)
Household Size	-.001	-.001	-.005	.007	.066	.001	-.005
	(.095)	(.129)	(.788)	(.861)	(.166)	(.050)	(.616)

	(1) Anemia	(2) Short Vitamins	(3) High Chol.	(4) High BMI	(5) 100-HEI	(6) High Sweets	(7) Food In-secure
Mother's BMI	.001	-.000	.004	.010	.016	-.003	.001
	(.364)	(.016)	(2.51)	(4.57)	(.164)	(.925)	(.570)
Male	-.166	.022	-.061	-.102	4.58	.055	.003
	(5.98)	(.800)	(2.66)	(3.53)	(3.42)	(1.33)	(.116)
Constant	.188	-.020	.010	-.226	45.72	.511	.073
	(1.30)	(.142)	(.086)	(1.50)	(6.56)	(2.38)	(.511)
R-squared	.084	.026	.031	.077	.036	.014	.060
Hispanics							
Education Head	-.003	-.008	.009	-.005	-.025	-.006	-.020
	(1.61)	(2.03)	(2.00)	(.971)	(.106)	(1.19)	(4.86)
Age Head	-.001	-.002	.006	-.002	-.052	.006	-.004
	(1.19)	(1.06)	(3.33)	(.772)	(.507)	(2.66)	(2.54)
Urban	-.006	.048	.039	.051	-3.08	-.050	.015
	(.391)	(1.83)	(1.26)	(1.35)	(1.85)	(1.33)	(.508)
Immigrant	-.019	-.028	.092	.066	-3.92	-.007	-.140
	(1.22)	(1.04)	(2.84)	(1.69)	(2.27)	(.186)	(.473)
Income < 1.3*	-.017	-.004	.089	-.115	2.09	-.039	.090
Poverty	(1.08)	(.147)	(2.65)	(2.83)	(1.17)	(.952)	(2.94)
Female Head	-.013	-.011	.089	.172	7.01	-.060	.054
	(.677)	(.334)	(2.30)	(3.65)	(3.38)	(1.28)	(1.51)
Household Size	.007	.014	-.026	-.005	-1.15	.029	.019
	(1.35)	(1.64)	(2.53)	(.367)	(2.09)	(2.35)	(2.04)
Mother's BMI	.000	.003	-.002	-.002	.650	-.007	-.005
	(.004)	(1.54)	(.645)	(.512)	(4.73)	(2.28)	(2.27)
Male	-.031	-.007	-.030	.017	12.30	.080	.137
	(2.21)	(.265)	(1.03)	(.473)	(7.77)	(2.22)	(5.06)
Constant	.105	.104	-.206	.135	25.06	.045	.467
	(1.48)	(.827)	(1.38)	(.745)	(3.16)	(.249)	(3.43)
R-squared	.039	.050	.117	.067	.252	.073	.215

Notes: T-statistics in parentheses. There are 371 whites, 527 blacks, and 402 Hispanics.

Table 7: Differences in the Effects of Information and Resources by Sex

	(1) Anemia	(2) Short Vitamins	(3) High Chol.	(4) High BMI	(5) 100-HEI	(6) High Sweets	(7) Food In-secure
Females							
Education Head	.0004	-.003	.003	-.016	-.57	-.0010	-.001
	(.105)	(.836)	(.840)	(3.85)	(2.78)	(1.65)	(.368)
Age Head	.002	-.000	.001	-.002	-.072	.002	-.003
	(1.68)	(.227)	(.503)	(1.31)	(.937)	(1.05)	(2.44)
Urban	.008	-.008	-.014	.037	-1.06	.028	-.008
	(.417)	(.395)	(.738)	(1.52)	(.914)	(.834)	(.474)
Immigrant	-.0002	-.016	.081	-.089	-4.55	.027	.008
	(.004)	(.403)	(2.31)	(1.99)	(2.11)	(.437)	(.268)
Income < 1.3* Poverty	-.004	-.032	.061	-.013	2.93	-.043	.079
	(.158)	(1.21)	(2.53)	(.422)	(1.99)	(1.03)	(3.45)
Female Head	.009	.032	-.053	.041	-1.93	-.012	.056
	(.339)	(1.14)	(2.05)	(1.24)	(1.21)	(.266)	(2.53)
Household Size	.007	.005	-.016	-.015	-.851	.012	.010
	(1.08)	(.710)	(2.40)	(1.80)	(2.14)	(1.07)	(1.87)
Mother's BMI	.0001	.007	.004	.005	.527	-.011	-.001
	(.056)	(3.99)	(2.08)	(2.54)	(5.05)	(3.71)	(.409)
Constant	-.090	-.075	-.038	.317	36.24	.507	.099
	(1.01)	(.781)	(.426)	(2.84)	(6.72)	(3.30)	(1.32)
R-squared	.062	.028	.047	.065	.107	.048	.082
Males							
Education Head	-.0001	-.005	.001	-.004	-.465	-.014	-.013
	(.096)	(.979)	(.520)	(.985)	(2.01)	(2.02)	(3.63)
Age Head	-.0001	-.002	-.001	-.001	-.080	-.003	.000
	(.339)	(1.40)	(.561)	(.625)	(.963)	(1.32)	(.037)
Urban	.002	-.061	.003	.023	-3.39	-.070	.012
	(.368)	(2.27)	(1.65)	(1.06)	(2.69)	(1.83)	(.603)
Immigrant	-.007	.085	.008	.010	-1.57	.052	-.071
	(.645)	(1.92)	(.309)	(.284)	(.752)	(.814)	(2.14)
Income < 1.3* Poverty	.002	.069	.046	.089	-.164	-.024	.058
	(.265)	(2.07)	(2.34)	(3.24)	(.104)	(.512)	(2.34)
Female Head	.0002	-.007	.027	-.004	2.08	-.005	.170
	(.019)	(.182)	(1.27)	(.148)	(1.20)	(.096)	(6.21)
Household Size	-.0002	-.015	.003	-.009	.269	.005	.016
	(.087)	(1.73)	(.543)	(1.24)	(.669)	(.402)	(2.50)
Mother's BMI	-.0000	-.001	-.002	.006	-.029	-.002	-.001
	(.093)	(.647)	(1.47)	(3.17)	(.284)	(.628)	(.427)
Constant	.0080	.378	.049	.010	53.95	.587	.124
	(3.84)	(3.13)	(.690)	(.098)	(9.52)	(3.41)	(1.39)
R-squared	.032	.045	.040	.068	.038	.044	.186

Notes: T-statistics in parentheses. Regressions also include race dummies.

Table 8: Trends in BMI Regression Results - NHANES I,II, and III

	(1) NHANES I	(2) NHANES II	(3) NHANES III
Education Head	-.0036	-.0028	-.012
	(3.6)	(1.5)	(4.0)
Age Head	.00024	.0016	-.0012
	(.33)	(2.2)	(1.1)
Urban	-.012	-.0037	.030
	(.99)	(.28)	(1.9)
Immigrant	.0053	-.053	-.039
	(.26)	(2.4)	(1.4)
Income<1.3*	-.014	.013	.043
Poverty	(.92)	(.86)	(2.1)
Female Head	.0073	.0021	.018
	(.42)	(.13)	(.81)
Household Size	-.0066	-.003	-.011
	(2.2)	(.90)	(2.1)
Male	-.030	-.032	-.044
	(2.7)	(3.0)	(2.9)
Black	.028	.0062	.017
	(1.6)	(.36)	(.73)
Hispanic	-	.056	.018
		(2.2)	(.67)
Constant	.22	.040	.33
	(4.1)	(.85)	(5.0)
R-squared	.0194	.0191	.0445
N	1,697	1,509	1,358

Notes: T-statistics in parentheses. Non-English language spoken at home is used as a proxy for immigration status in the NHANES I sample.

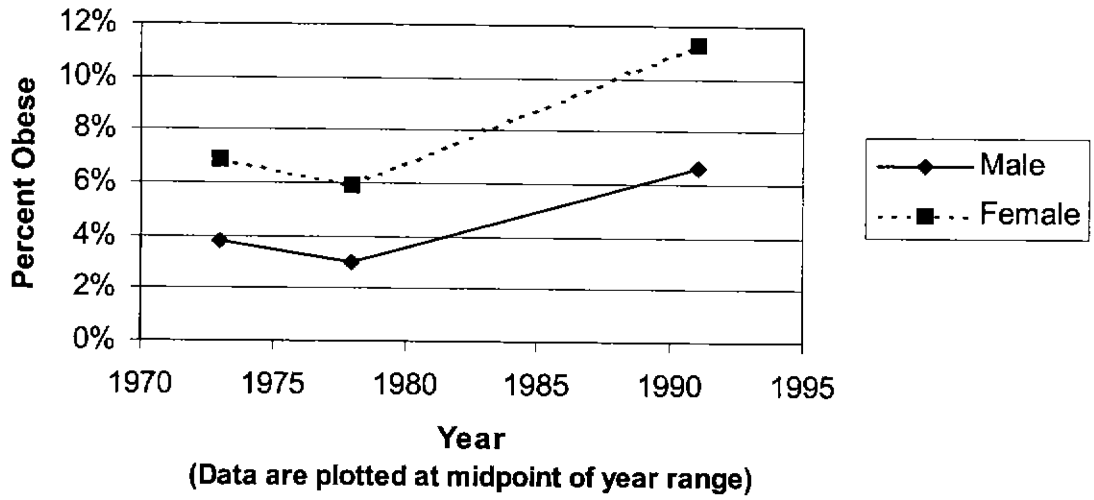

Figure 1: Trends in Obesity by Sex

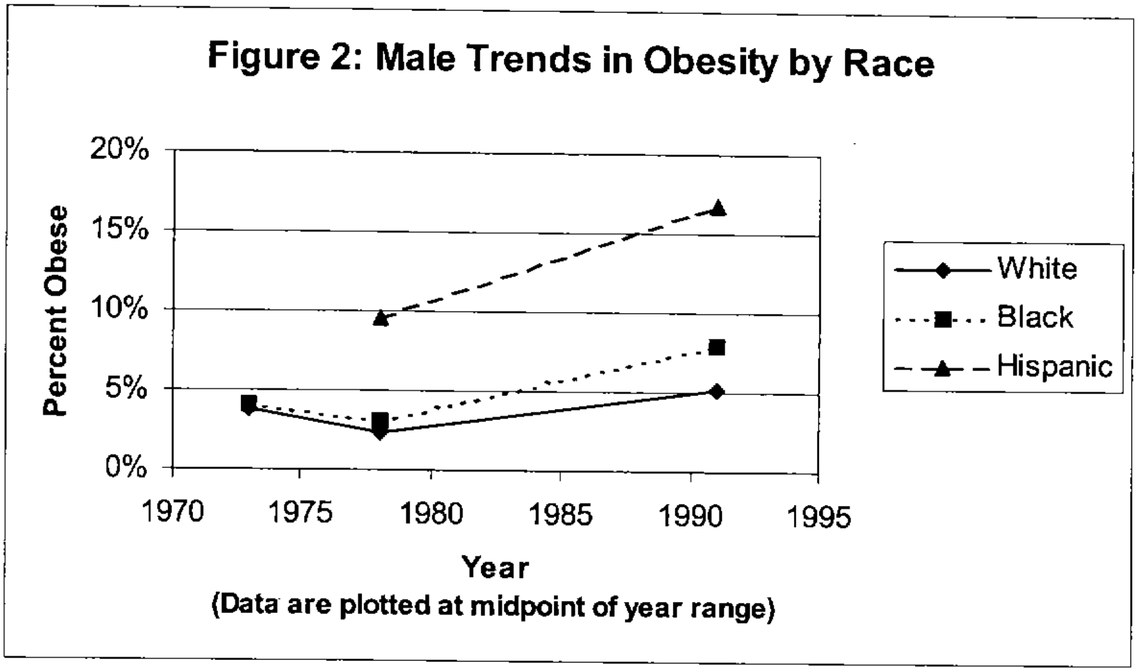
Figure 2: Male Trends in Obesity by Race
20%
15%
10%
5%
0%
Percent Obese
1970
1975
1980
1985
1990
1995
Year
(Data are plotted at midpoint of year range)
White
Black
Hispanic

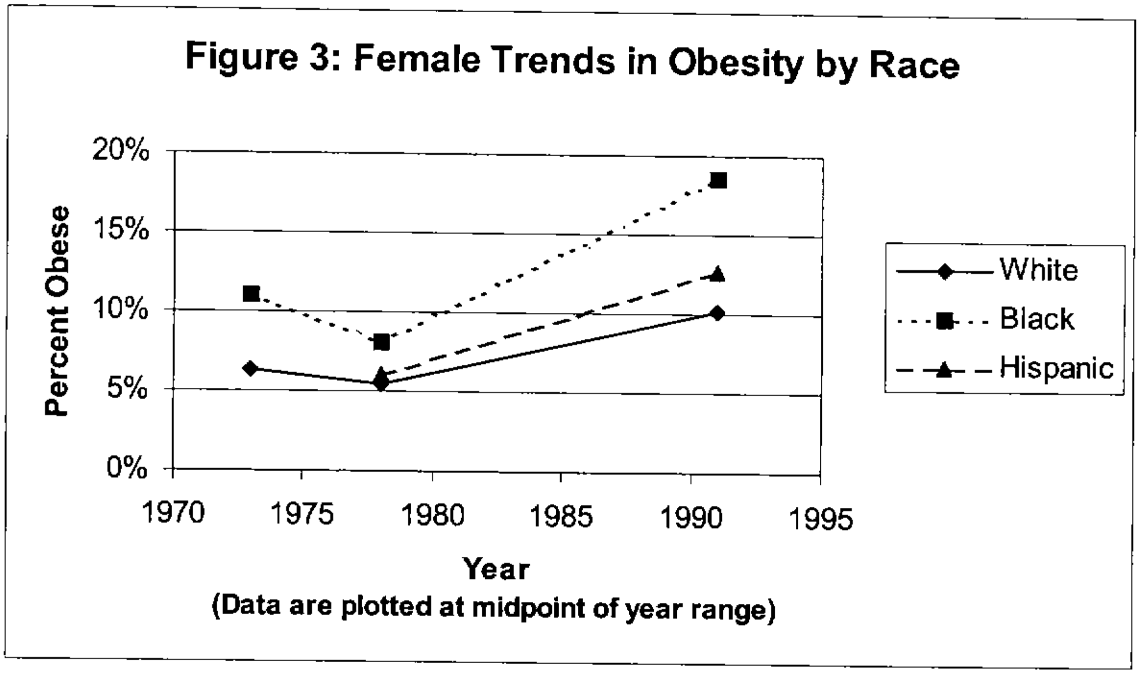
Figure 3: Female Trends in Obesity by Race
Percent Obese
20%
15%
10%
5%
0%
1970
1975
1980
1985
1990
1995
Year
(Data are plotted at midpoint of year range)
White
Black
Hispanic